Unpublished manuscript prepared for the Ernst Strüngmann Forum:

Complexity and Evolution: A New Synthesis for Economics

February 1–6, 2015

Early Draft Background Paper for the *Shaping the Evolution of Complex* Societies Group

Complexity Economics and Workaday Economic Policy

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For those of us working in complexity economics, it is an exciting time, and we sometimes wonder why all economists can't see complexity's potential and usefulness. Why doesn't everyone join us and jump on the complexity bandwagon? One reason why is that much of what filters down to standard economists from complexity economics are summaries of abstract analysis--critiques of Walrasian general equilibrium theory, discussions of butterfly effects, sensitive dependence on initial conditions, and stories of "living economies in a computer"—stories that, while interesting, are generally seen as having little direct impact on the workaday policy analysis that most economist do.

The reality is that workaday economics is done with little reference to abstract theory, new analytic techniques, or advanced computational technology. You don't teach general equilibrium to beginning or even intermediate students; you're lucky if they follow supply and demand. You don't base your policy analysis on general equilibrium theory; you develop a simple model, collect data, process that data and come to a conclusion. Abstract theory, whether complex or not, has little direct relevance to workaday economics.

Despite its lack of direct relevance, most economists are interested in complexity economics. But they are interested in it as a consumption good— a throwback to the abstract thinking done in graduate school in late night bull sessions where they asked the big questions, not as a production good--as something that affects their applied policy research. The general sense of standard economists is that when it comes to their applied policy analysis, complexity economics has little to add, other than that the economy is complex, something they already knew.

The goal of this paper is to challenge that view, and to explain why complexity has enormous implications for how workaday applied policy economics is done.[1] My argument can be summarized as follows: Complexity economics involves both a *complexity scientific theory* of the economy and a *complexity vision* of the economy. Most economists are willing to accept that the vision of the economy as a complex evolving system undergoing continual evolutionary change is interesting; it resonates with their intuition. But economists are generally far less likely to accept that a complexity scientific theory of the economy is ready for prime time. For them, complexity economics hasn't cleared the scientific bar. Because standard economists see good applied policy as applied science, it follows that, for them, complexity economics has little relevance for their workaday applied policy.

[1] It also has significant implications for how economics is taught, but that is involves a different set of issues than I will discuss here.

In this paper I will argue that that view of "applied policy as applied science" is wrong. The centrally important creative and design part of applied policy is not dependent on the reigning scientific paradigm because it is not applied science. If done in a reasonable way, it has little concern with what the scientific paradigm is.

This "applied policy is not applied science" approach is well understood, and followed, in the engineering profession. It is not understood, or followed, in economics. A change in that view would have significant implications for workaday economics, making workaday applied policy analysis much more open to complexity and evolutionary policy insights. It would mean that economic policy work would not be limited by what we scientifically know; it would be based on any information, or idea that might be useful in fashioning a solution to the policy problem one is considering. So even if one holds that complexity science is still in the formative stages, and that complexity analytic tools and models are not ready for prime time, complexity economics still can have important implications for how workaday applied economic policy is done.

The structure of the paper is as follows: I will first discuss complexity science and vision, and their relation to economist's current policy frame. Then I discuss why applied policy should not be seen as applied science, but rather as engineering, and how adopting an engineering methodology makes the complexity vision important for workaday policy analysis. I conclude by exploring some implications and examples of how using a complexity frame for economic policy changes workaday applied economic policy analysis.

Complexity Science and Complexity Vision

Policy is often thought of as applied science. What is meant by a scientific theory is generally ambiguous and much in debate, but in economics, economic science is usually interpreted as work developing out of existing Walrasian general equilibrium theory. Complexity science challenges that Walrasian general equilibrium theory as the core scientific theory. As Wilson et al. state in their overview paper for this conference, complexity economics challenges (1) the equilibrium focus of the WGE theory. (Complexity economics would model economic systems as "complexly adaptive and frequently out of equilibrium" not as a system in equilibrium), and (2) the unrealistic treatment of preferences and rationality in WGE theory. (Complexity theory sees preferences and tastes as endogenous and rationality as far more complicated than WGE theory does.) They argue that making these changes involves a paradigmatic shift in economics.

The problem for complexity economics supporters is that the large majority of economists are not ready for a paradigmatic shift in economics, not because they love general equilibrium theory, but because they have learned to live with it. The WGE theory serves as a background policy frame—providing the theoretical basis for cost benefit analysis, guidance for whether and how to internalize externalities, and for how to conduct tax and subsidization policy.[2] In fact it indirectly underlies almost all of economist's thinking about policy. It has been extraordinarily useful in structuring thinking about policy; it has met a usefulness criterion.

[2] Policy following from behavioral economics, such as nudges, is the exception. Because it is an exception, it has been slow to be accepted by standard economists as anything other than a tangential addendum to standard economic policy.

Despite its indirect importance, WGE has little direct relevance to workaday economic policy. Standard economists' actual workaday applied policy economics makes almost no direct reference to Walrasian general equilibrium theory, social welfare functions, or welfare theorems. That theory is too abstract to use directly when thinking about policy. For most economists, WGE is something they learned in graduate school and has since receded to the deep recesses of their minds. While it lurks in the background, it is not what they are thinking of when they do applied policy. Because WGE is not seen as directly relevant for applied policy analysis, complexity economists' challenge to WGE is seen as having little relevance to them. They do applied policy analysis, and the musings of economic theoreticians worried about abstract complexity issues, is seen as having little direct impact on what they do.

For most standard economists, even those sympathetic to complexity ideas, complexity economics does not yet meet the standards of scientific understanding. It involves conjectures and speculation about the economy that, while interesting, are scientifically unproven and thus remain in the speculative branch of economics. In most standard economists' eyes, complexity economics is not yet ready to replace WGE theory, which, while limited, and hobbled by untenable assumptions, is at least logically correct, and has been demonstrably useful in providing a guide for policy.

I am not a scientific methodologist, and am not qualified to render a meaningful opinion on whether using WGE theory as economist's core scientific model is appropriate or not. My leanings are that it is not, but I accept that, by design, formal scientific general theories embody unrealistic assumptions. Scientific theories are developed to provide abstract understanding, not policy guidance; unrealistic assumptions are the cost of the clarity need for truth. Thus, I can accept that keeping WGE as the scientific theory might follow from scientific methodology, which places an enormous burden of proof on a new theory. Paradigmatic changes in science do not, and should not, come lightly; scientific methodology is designed to counter people's proclivity to be fast pattern completers—and see things that are not there. Scientific methodology involves what I call a set of slow pattern completing rules. That conservative methodology is designed to insure science is based on most likely true knowledge.

The above issues are debatable, but for purposes of this paper, I will accept that the arguments for keeping WGE as economist's scientific theory are tenable. For most economists, that is the end of the story. For them, since complexity isn't ready to become the new paradigm in economics, it has few implications for applied policy since applied policy is applied science. It is that step that I want to challenge here. I argue that applied policy should not be seen as applied science, and that even though much applied policy is done with little thought of formal scientific methodology and GET, indirectly both limit what economists do in their applied policy. If applied policy is more explicitly seen as engineering, the debate about what economist's scientific theory is becomes almost irrelevant to how applied policy analysis is conducted. That allows complexity to influence economist's policy analysis in ways that it currently does not.

Applied Economics is not Applied Science

If applied economics should not follow a scientific methodology, what methodology should it follow? My answer is that applied economics should follow *an engineering methodology.*[3] Engineers do not see engineering as applied science. Engineers use science, and

[3] I develop this argument in more detail in Colander (2014)

where appropriate, use scientific methodology, but engineers differ from scientists in that they allow and encourage policy analysis to be based on intuition, guesses, gut feelings and a whole variety of elements that they do not claim meet scientific muster. The reason why is that good engineering is a creative endeavor; it is not a formal scientific endeavor, and its goal is to solve problems--to discover solutions that work in the real world, not to find capital T (or even small t) truth. If a solution that works in the real world doesn't work in the existing scientific theory, so be it.

Billy Vaughn Koen (2003) defines the engineering method as *"the strategy for causing the best change in a poorly understood or uncertain situation within the available resources."* Or alternatively he defines it as the *use the best available engineering heuristics to solve problems.* Those definitions serve as useful statements of the method appropriate for workaday applied economic policy. Koen emphasizes that since no part of knowledge is infallible; appropriate heuristics include all theories and models, *and any other aid*, such as intuition, experience, and expert knowledge that may usefully lead to a solution. In this engineering method, nothing is off the table. By explicitly calling the models and other aids that an engineer uses to arrive at a conclusion, heuristics, he calls attention to any model's problems, and encourages a methodological approach that is open to all evidence and arguments. Engineering, and hence applied policy, has a different threshold of importance than does science. Science is searching for truth; engineering is searching for answers to policy questions.

Translated into economics, this means that WGE is simply one of many heuristics that might be useful in solving the wide range of policy issues that economics considers. Its usefulness in applied policy can only be ascertained by considering how its usefulness compares to other heuristics', such as a complexity policy frame's, usefulness for the particular problem at hand. An applied policy economist following an engineering methodology would be continually trying alternative heuristics to see which is most useful for a particular set of problems; he or she would be far less tied to the standard WGE policy frame than standard economists are.[4]

Koen emphasizes that the appropriate heuristics will be constantly changing, and discussion of them will be part of what every engineer does. Thus, while abstract methodology is not much discussed by engineers, practical methodology is constantly discussed. It is integrated into what engineers do, so all engineers are simultaneously engineers and methodologists. Put another way, methodology is an important part of engineering, but it is a narrow applied micro methodology of best practices for particular areas, with a very loose general methodology that can probably best be described as an *educated common sense* methodology. Koen calls it a "universal method." The particular branch of engineering, and the particular problem the engineers are trying to solve, will determine how important the scientific heuristic is and how important other heuristics are. There is no one overriding engineering heuristic. Engineering heuristics make no attempt to be a value-free. Engineering recognizes that values are in integral part of policy analysis, and instead of trying to be value free, is concerned with making the values in the analysis clear, so outsiders can decide whether they agree with them or not.

[4] Extreme care must be used in actually applying heuristic insights into policy, and in insuring that moral issues are integrated into the analysis, which is one of the reasons the welfare economics followed the path that it did; it wanted to avoid dealing with issues of morality and value judgments. But, as Hume long ago noted, policy inherently involves morality and value judgments. To pretend they are not there is not a viable option.

Thinking of applied economic policy as engineering, not science, opens up new avenues of policy considerations that allow complexity insights to enter the policy discussion long before the science of complexity is ready for prime time. It encourages economic discourse about policy to include much more daydreaming, speculation and playing around with ideas. Specifically, using an engineering methodology for applied policy, the assumptions that currently guide much of the policy analysis done by economists—exogenous tastes, no interdependent utility functions, no contagion, no evolutionary institutions, and extreme rationality—would not be limiting on policy analysis. They were only used because they led to tractable scientific models—all have their roots in the WGE model not in their usefulness for policy, but their usefulness in finding the truth.

Using an engineering methodology, the standard assumptions would no longer hold the power over applied policy that they currently do. The WGE heuristic would likely be replaced by a variety of heuristics that are more consistent with observed empirical reality for policy purposes, even as one kept WGE as one's scientific theory. Using the complexity vision to think about policy allows applied policy analysts to modify scientific assumptions for their policy heuristics, and to explore policy issues that are outside the standard ones economists examine. Eliminating these arbitrary assumptions would change policy analysis enormously. It would open up a wide range of policies to exploration by economists using different models.

Let me be clear; my argument is not that the complexity vision would overthrow existing theory and applied policy. Where the existing models work better than the new models as a guide for policy, the existing models will continue to be used. But what works best—what is the best current state-of the art heuristic—can only be known by comparison of the usefulness of the various models. It is that comparison that is not happening now.

Implications of the Complexity for Policy

If the engineering approach to applied policy were followed, the complexity frame for policy would be one of the alternative frames that would be explored. In Colander and Kupers (2014), I have explored some of the ways in which thinking about policy would change using a complexity frame. They include:

1. We don't understand the complex evolving economy, and probably can never understand it fully. Complex systems are not amenable to control, and we should give up the ambition to control the economic system.
2. While we cannot control the economy, we can influence it in a myriad of ways; the standard policy model rules out many of these avenues; influence comes about not just through incentives within the existing institutional structure. A key focus of policy within the complexity policy frame involves positively influencing the evolution of institutions. It involves issues of formation as well as allocation.
3. The economy and the government are co-evolving complex systems that cannot be considered separately. There aren't separate market and government solutions to problems. Solutions can be more bottom-up or more top-down, but both require some type of either explicit or implicit government policy to bring about, even if that policy is to do nothing. The market is not the opposite of the government; successful market economies are testimonies of the success of previous government policies.

4. The success of bottom-up policy depends on the ecostructure within which people operate and the normative codes that they follow. Thus ecostructure and norms policy are central to complexity policy.
5. There is no general complexity policy; complexity policy is contextual, and consists of a set of tools, not a set of rules, which helps the policy maker to come to reasonable conclusions.
6. Government is an evolving institution, and can evolve in different ways. Complexity policy includes policies that affect government, and the role of government will change with the problems and the current state of government. There can be no non-contextual general policy recommendations.
7. Complex systems often experience path dependencies, non-linearities and lock-ins. Methods need to be designed to determine when these have occurred, and policies reflecting these dynamics need to be designed to influence the economy's evolution.
8. Policies can be achieved with bottom-up or top-down methods of influence. Top-down policies should not be seen as a one-time policy, but as a policy process that evolves as institutions evolve. Bottom-up policies allow endogenous evolution as institutions involve.

How these issues relate to policy involves a multifaceted set of considerations, that can only be touched on in the space I have available, but in the following I will give a sense of how I see them affected workaday applied policy economics.

Ecostructure and Activist Laissez Faire Policy

A major difference between the complexity frame and the standard WGE control policy frame is that the complexity frame does not see the market and the government as polar opposites; it sees them as having co-evolved, and as highly interdependent. This means that complexity policy analysis can't use a market solution as a reference point for policy analysis because the market would not exist without government. In the complexity policy frame "efficiency" is not a general goal within the model; the policy goals have to be specified by the policy analyst. Efficiency has meaning only in relation to those outside specified goals.

What in the WGE policy frame are seen as market failures are, in the complexity frame, seen as ecostructure failures—they involve a failure in the formation of institutions. Policies on how to effectively deal with these failures might involve either more or less direct government involvement. Complexity theory does not tell you which. Put another way, instead of a market vs. government policy dichotomy, the complexity policy frame one has a bottom up vs. top-down policy dichotomy, and the choice between them is based not on theory, but rather on judgments such as a judgment on how similar policies have worked elsewhere in similar circumstances. In the complexity policy frame there is no definitive theoretical argument for or against a policy—instead a researcher uses history and context specific model heuristics as guides.

Bottom-up policy is the complexity equivalent to laissez faire policy. But bottom-up policy is quite different from laissez faire as is often interpreted. Within the complexity frame, laissez faire is a government policy of encouraging bottom-up solutions to problems; it is not an

absence of government policy.[5] Bottom-up policy has government actively encouraging individuals to solve their own problems, and providing an ecostructure that will help them do so. It tries to maintain fairness, but otherwise stay out of the way. Top-down policy is designed to solve the problem using existing government institutions. Bottom-up policy tends to be slower than top-down policy, but it also tends to be more robust since it uses individuals' local knowledge that is unavailable to government policy makers.

In the complexity frame there is no necessary correlation between one's concern about social problems, and one's view of the efficacy of top-down or bottom-up solutions. For example, one can be enormously socially concerned, but still be a strong bottom-up policy supporter if one's assessment is that government top-down policies to deal with social problems have serious negative side effects. Elinor Ostrom's work provides guidance for thinking about bottom-up policy within the context of common pool resources, and she and sophisticated interpretations of Ronald Coase's work (Medema, 2011) can be seen as the early pioneers of the complexity policy frame.

Developing the Ecostructure to Achieve Social Goals

One way to show how using a complexity frame changes workaday applied policy work is to discuss how it has changed my applied policy work. In my current research, I am part of a large group working on developing an ecostructure that will encourage bottom-up solutions to social problems. The research involves understanding the nature of what we call for-benefit enterprises, which are market oriented enterprises run to achieve social goals, not private goals. (See Colander, 2011) There is enormous interest and support for the development of these institutions, but it is mainly interest by politicians, lawyers, and businesspeople. I am one of the few economists working on the project.

My interest in this research program came about from talking to some successful socially concerned entrepreneurs who had earned sufficient income to fulfill all their material needs and wants before they were 30, and who were turning to philanthropy. After exploring existing non-profits they became disillusioned with their effectiveness, and were looking for a better way to achieve their social ends. That led them to exploring whether they could set up private enterprises that would be devoted to solving the social problem they were interested in. Instead of just giving money, they wanted to "invest" and manage the enterprise whose bottom line would be their social goal. Interest in the topic led to a movement to create a 4th sector of the economy—one that would have many of the governance structures of private enterprises, but would have social, not private profit, goals. My contribution to the project has been in (1) exploring what standard economic theory has, and in the past has had, to say about profit maximization (they are different) (2) explaining economist's approach to integrating normative views into their analysis of the way the market works, and (3) exploring how the type of institution they would like to set up differs from other related institutions, such as L3C's, B-corps, triple bottom line companies and social businesses. The project has me working with lawyers, business people and policy wonks, on specific policy questions. The research has far

[5] As I have discussed elsewhere (Colander, 2009) sophisticated Classical economists saw policy in this way, and is what Lionel Robbins meant when he said that "laissez faire is the state".

less focus on general solutions than my previous standard applied policy research had been.[6] Even though the project does not focus on general solutions, it has led me to think about them and work on a paper that contrasts a "pure for-(social)-benefit enterprise" with its pure polar opposite--a "for profit" enterprise of standard theory, with most real world firms falling somewhere between the two extremes.

The project is very much applied policy work, but it is applied policy work that is quite different from the applied policy work done in standard economics. It is suggestive of how applied policy work would change if economists adopt a complexity policy frame. It has been much more collaborative and transdisciplinary than my other research. It involves much more thinking outside the standard model, and significant study of past economist's writing, as I try to come to grips with how economist's current policy heuristics evolved. The focus is on finding practical solutions to specific problems and issues. The research might lead to a "general solution" but the flow is from *specific to general* solution, not from *general to specific* solution as it is with most current "standard" economic work.

Policy based on Replicator Dynamics

The last section described how my research agenda changed when I switched to a complexity policy frame. Let me now turn to a different way in which complexity will likely change workaday applied policy economics. Complexity economics gives researchers a new method of simplification and new analytical and computational tools that free economists from relying on developing a specific analytically solvable model. Instead of building an equilibrium model, they can develop and explore an evolutionary model within which the research only has to specify the replicator dynamics, not the full equilibrium system.

Supplementing the standard policy frame with the complexity policy frame makes applied policy economists far less dependent on being able to specify the equations in the model, and basing their policy analysis the equilibrium properties of the model. In the complexity frame, instead of picturing the economy as a set of interdependent equations moving toward equilibrium, as is done in the standard policy frame, researchers can picture existing reality as the result of replicator dynamics that evolve over time. They can then create agent based models to analyze those replicator dynamics, and explore alternative policies designed to influence those replicator dynamics within these agent based models.[7] Agent-based models allow researchers to explore, and base policy thinking on, non-linear dynamic models in which complex realities emerge and evolve. This means that tractable unique equilibrium models no longer need to be assumed; in fact, the very concept of equilibrium can be replaced by a new concept, basins of attraction, which opens up the formal study of equilibrium selection mechanisms. As these replicator dynamics complexity models are explored, new possibilities for policy will emerge.

[6] In the month preceding this conference, I attended two conferences related to this 'for benefit' topic—one in Washington sponsored by the Fed and the Urban Institute, and another at Harvard sponsored by INET and Harvard. Both were highly interdisciplinary and involved issues normally considered outside the purview of economists.

[7] Important developmental work is being done in expanding and developing agent based modeling's relevant for policy. For example, George Mason has developed a Computational Public Policy Laboratory under the direction of Rob Axtell and Josh Epstein (2014) has recently expanded the nature of agents to include neurological foundations allowing additional exploration of behavioral issues with agent based models.

The change is similar to the change that is occurring in medicine, where standard medicine, which conceives of health policy as fighting germs, viruses, and bacteria. This approach is being currently supplemented by two alternative approaches. One is an evolutionary approach in which individuals are seen as ecosystems for billions of organisms who coevolve with individuals. Within this frame a person's health dependent on how that entire ecosystem works. A second approach is a genetic approach, in which an individual's genetic code plays a central role in his or her health. In genetic medicine a minute change in the genetic code can have enormous effects on the health of an individual. In both these approaches germs only capture part of the story. Just as the development of genetic and evolutionary theory have opened up entirely new branches of health policy, so too can the complexity frame open up entirely new branches of applied economic policy.

A Norms Policy

Once one thinks of the economy system in terms of its replicator dynamics, one is led naturally to a new type of economic policy for applied policy economists to explore: norms policy. Norms policy is a policy designed to achieve desired ends by influencing the tastes and norms of individuals. The reason one is led to norms policy is that in the complexity frame norms are endogenous, so they naturally become part of the policy discussion.[8]

Accepting that norms are endogenous has significant implications for workaday applied policy analysis. For example, economist's current control policy frame directs researchers to think of policy in terms of government passing a law, a tax, or some other control measure to achieve the desired result. But that need not be the case. Once one uses a complexity model that has endogenous norms, mores, and culture determining behavior, one is presented with a much expanded role for government not as a controller, or law maker, but as an influence of norms. In our book on complexity and the art of public policy Roland Kupers and I argue that one of the most important roles for government is to provide a moral compass for society. If government fails in providing a moral compass, it will likely fail in everything. Once it has provided that moral compass, it can consider policies that are designed to positively influence the norms in society. Behavioral economics' "nudges" are beginning to explore this policy space, but the implications of endogenous norms and tastes go far beyond nudges.

Another example of a policy that the complexity frame leads researchers to explore involves adding a new set of policy tools—influence tools—to its policy arsenal. Influence tools are ones that guide individuals toward "positive" norms. They might involve measures legislating a new type of "government guidances", by which I mean laws that are not enforced through power, but through social pressure. What I am thinking of is something like a fatwa in Islamic religion. These set of guidances might be called legislated mores; they are what people, through government, have decided are positive rules of behavior. Violating a more would not be punishable in the way a misdemeanor or a felony is; it would not lead to a fine or imprisonment, but it might lead to public disapproval, and serve as a basis for deciding whether a person behaved appropriately in insurance and private tort claims.

Many of the grey areas of current policy, where individual rights seem to conflict with what society considers good practices, could be dealt with using these government specified

[8] Important work along these lines has been done by Ernst Fehr and his fellow researchers. (Fehr et. al. 2009)

mores. Examples where such mores, rather than laws, might be useful include activities such as wearing a seatbelt, using drugs and certain sexual behaviors. Actions that are now criminalized could be decriminalized but simultaneously discouraged. How effective will such mores be? That is an empirical issue that applied policy economists using the broader complexity frame would explore as part of their analysis of the relative effectiveness of alternative methods of discouraging behaviors that people, through government, have decided to discourage.

An Alternative Complexity Policy Approach to Achieving a more Desirable Income Distribution

Let me conclude this brief consideration of the way in which workaday applied policy analysis would change by considering how economist's policy approach to a specific problem—income distribution—might change if they adopted a complexity frame. Economist's current applied policy heuristic deals with income distribution as a *re*distribution problem. By that I mean that it takes marginal productivities as given and asks: How one can develop redistributive taxes that bring about a more desirable income distribution?

The complexity frames suggests an alternative approach. As opposed to trying to *change the income distribution given marginal productivities*, in the complexity approach one might consider policies that change tastes, norms, and institutionally determined marginal productivities. The policy can be designed to structure the property rights and institutions so that the marginal productivities of individuals are more equal, thereby making the distribution of income more equal without resorting to redistributive taxation. Here are some examples of policies that could be examined that might achieve that end.[9]

- Property rights could have a more limited duration than they currently have. Patent and copyright laws could be designed for much shorter periods, so that the benefits of the work are passed to the broader public.
  - Intellectual property rights could be significantly limited.
  - Institutions favoring open source software and material could be institutionally encouraged.
  - Instead of perpetuity property rights in land, 100 year leases could have been given, with the land reverting to social wealth, and re-leased, when the lease comes due.

- Competition could be more strongly supported by limiting government supported monopolies.
  - Regulatory structures of institutions could allow for narrower specialists, so that the rents created are spread more widely and more competition is created.
  - Open certification not requiring specific high-priced formal training programs, but rather "open-to anyone" certification exams, could be instituted.
  - At risk students could be provided with a "bottom-up" educational option, in which, they receive the money that would have gone into educating them if they learn the material on their own.

[9] This discussion is based on Colander (2014). The ideas here are not tied to taking a complexity view, but taking such a view is much more likely to lead economists to make such policies a central focus of their research. For a nice discussion of problems with existing policy toward property rights, see Michele Boldrin and David Levine.(2010) and Cory Doctorow, (2014)

- Individual's social, not materialistic, proclivities could be encouraged.
  - The society could advocate and support a stronger tradition of social responsibility of the rich, so that achieving social goals becomes a favored luxury good of the rich. Andrew Carnegie's *Gospel of Wealth* could be built into the fabric of society.
  - Institutions could have been designed to encourage social benefit, rather than private benefit, entrepreneurship.
  - Materialism embedded in the GDP goals could be countered by replacing GDP with other measures of social success such as Sen's Capabilities Index.

Conclusion

I began this paper with a discussion of how most economists see complexity economics as having little effect on their workaday applied policy economics. The goal of this paper was to convince the reader that that view is wrong—complexity economics makes an enormous difference for applied policy workaday economics. It does so by leading economists to a different way of framing policy—one that sees their work not as applied science, but as engineering.

Creative design engineering involves asking big questions that go beyond those that we can deal with in science, such as what happens to effective policy if tastes are endogenous; how would an economy function with a different set of property rights; how might we change laws to make for-benefit institutions more prevalent, what institutional setup would lead to what society would see as a fairer distribution of income. It explores different answers to those big questions by changing them into real world policy questions that can be answered with existing computational and analytic technology.

Economists have failed society because they haven't done this. By allowing their policy discussion to be guided without explicit consideration by the WGE policy frame, economists have stopped asking the big questions that might have been intractable when the WGE frame was first adopted, but which are no longer intractable. Economic policy hasn't kept up with analytic and computational technology. In doing so they have missed asking obvious policy questions. The exploration of policy within a broader complexity frame will open up new avenues for economic policy analysis.

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